MOTOR RETARDATION AS A MANIC-DEPRESSIVE SYMPTOM.

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CONTENTS.

1. THE EXPERIMENTAL CRITERION OF RETARDATION.

Our reaction to a given situation is determined by the lines of least resistance in the nervous pathways at that moment and to that stimulus. This " set " of the nervous system is determined essentially by the various impulses that have traversed it before, and by immediate conditions of nutrition. These factors give a series of lines of least resistance to an indefinite number of situations, and the reaction to any of these situations will be along the line of least resistance which the past history of the individual has determined for it. The factors which go to determine these lines of least resistance are normally and naturally selected in such a way as shall be most beneficial to their possessor. It is apparent how largely the teleological character of our behavior depends upon the maintenance of the fine balance in the nervous pathways in favor of the most advantageous series of responses. One can also readily figure the profound disorder of behavior inevitably resulting from any disturbances of this " neural balance," be these disturbances themselves the ultimate products of intoxication, or of faulty habits of action and thought.

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In a fundamental retardation we have an agency or number of agencies, presumably of toxic origin, which tend to increase the difficulty with which certain nervous impulses, consequently certain psychic functions, can proceed. The actual study of cases shows us that the symptom of retardation may involve the various mental functions largely independently of one another. When its manifestations occur mainly in the higher, associative processes of the mind, we speak of it as a " difficulty in thinking " or " thinking disorder " ; we may also see its phenomena confined with some definiteness to the motor side ; and as has been elsewhere suggested, those manic-depressive states which show an emotional condition of apparent apathy in contradistinction to depression are the manifestation of this same symptom in the affective sphere. In like manner we may find these phenomena even more restricted within the categories mentioned.

It is obvious, however, that in merely speaking of a " greater difficulty " of the nervous processes, we do not tell the whole story of the effect of this difficulty upon the resulting movements, which are, of course, our ultimate criteria of the symptom. The response may be merely delayed, without seeming to be otherwise affected. More often, however, there is coupled with this delay a certain weakening of its force and effectiveness. On the other hand, the response may be long delayed and then come with explosive force, as though the patient had been gradually accumulating sufficient energy to burst through the retardation. Occasionally the response fails entirely, apparently from not being strong enough to break through ; this is apt to be the case with indifferent situations. Under great stresses, however, a marked retardation may be entirely swept away, indicating a considerable reserve strength of the voluntary impulse, just as our muscles seldom if ever put forth under voluntary stimulation the effort of which they are physiologically capable.

Clinically, we judge of a patient's retardation through the general character of his behavior, by the quickness with which he seems to think or speak or move. Experimentally, we make use of the innumerable tests put forward as measures of mental time. So long as we deal only with the presence or absence of retardation in general, the precise mental function that we select to measure is probably of secondary importance to the accuracy of

the experimental method itself. Most such experiments, however, would afford very little information about the character of the retardation, whether concerned with the lower, motor, or higher, associative processes. A purely intellectual retardation we cannot measure directly by any psychological methods at present known, for we always require some form of motor response in addition to the intellectual or associative process. We may first turn attention therefore to the functions which are more primarily motor, attempting to make our measure of retardation, so far as possible, independent of the higher mental processes.

To experimentally isolate mental retardation from motor retardation is no easy task. Almost every experiment in the time relations of voluntary movement involves a conscious process of greater or less complexity, followed by a motor response. While this is not absolutely true (as in simple reaction time in late practice) it is essentially so in the situations with which we have to deal clinically. For rough and ready purposes, some idea can be gained from the comparative degrees of retardation in responses involving different degrees of purely mental effort. Thus if a subject could calculate but slowly, and yet could respond quickly to commands, the indication would be that the retardation was mainly in the nature of a thinking disorder. On the other hand, the more the simple and complex responses were equal in slowness, the greater the likelihood of a retardation principally in the lower, motor centres. The presence of a certain amount of ordinary motor activity does not prove the absence of a motor retardation. The essential point here would be whether the *reactive* movements are quick or slow, and this does not appear in the ordinary observation of a patient's behavior. The phenomena which seem to be associated with motor retardation in these experiments have appeared most strikingly in cases in which little if any retardation would have been evident to ordinary clinical examination.

But, as has been said, the time of reaction in most psychological experiments is an unsatisfactory measure, since there is not sufficient differentiation between the mental and motor aspects of the symptom. Even such a measure as simple reaction to sound is, at all ordinary stages of practice, seriously vitiated by this difficulty in interpretation. Obviously, the simpler and more in-

dependent of the higher centres we make our experimental process, the more exclusively it becomes concerned with the purely motor factors, and a measure of time relations in the motor sphere.

Of those reactions to external situations which are so automatic as to be largely independent of control of the higher centres, the eye movements are the most important. Theoretically, I should consider the ocular pursuit reaction (Diefendorf and Dodge) as altogether the best criterion of retardation by the method of reaction to external stimulus. The present criterion of retardation possesses a good quality in that it is not immediately dependent on reaction to external stimulus, as well as certain minor technical advantages.

The psychological process involved in the successive movements of the tapping test is not clearly made out. It is, however, the verdict of introspection that the successive taps at maximum rate are not each the product of a separate conscious innervation. Nor can we conceive of the process as one of successive simple reactions to the various kinæsthetic sensations that the movements of the test present. The normal initial rate of tapping (about 7 per second) cannot be executed without 14 co-ordinated movements per second, and in reality the process is much more complex. Only the simplest reflexes have such a rate as this; no movement in which a voluntary process shares. A series of taps at the maximum rate is therefore a product of but few volitional processes, which merely give a " set " to which the organism responds by a continued series of reflex responses.

What then determines the rate at which these reflex responses take place? It is *limited* by the refractory phase of the neurone-paths, but, save in late practice, it is much slower than this; it is a matter mainly of efficiency in co-ordination. Beyond this we must judge purely empirically, by noting the external conditions which affect it. In normal individuals it does not seem to be especially influenced by conditions which are open to introspection. On the other hand, any previous activities tending to produce the " *Erregung,*" of Kraepelin, seem to increase the rate. If carried to the point of physical fatigue, the rate is decreased; but it does not seem that what is ordinarily called " intellectual fatigue " has any marked effect. If the tapping be continued, there results the decrease in efficiency ordinarily described as fatigue. This

can hardly be dependent on muscular factors, since it normally is a matter of about 14 per cent within 180 taps, and the isolated muscle would hardly fatigue to rapidly succeeding stimuli in this way. Nor has it any but a very indirect relation to the sensations of fatigue, which are presumably of muscular origin. The process can only be described as a decreased efficiency of coordination (possibly also to a proportionate lengthening of the period of the refractory phase). Both the absolute rate and the fatigue phenomena of the tapping test seem thus to be determined by obscure conditions of neural tone.

Once the general volition to tap as rapidly as possible is obtained, the minute features of the process go on in relative independence of conscious influence; it is not therefore a function that we should expect to see especially influenced in the presence of a pure thinking disorder. This might affect the time taken to respond to the signal to begin to tap; but once the tapping is begun, its rate is rather a matter of raised or lowered *Willens-spannung,* using this term in a wholly objective sense.

The efficiency of this purely motor responsiveness of the organism, the maximum rate of repeated voluntary movements measures in a relatively unequivocal way. For the rest, it is an ordinary work-curve, such as may be obtained in any continuous psychological experiment, being subject to and reflecting all the influences which affect the curve of work. Fatigue, and the reflex inhibitions resulting from sensations of fatigue, tend to produce a decrease in efficiency. Factors having a favorable influence are the so-called " warming up " processes, as well as any more or less external influences that may spur the organism to greater effort. The work-curve that we finally obtain is the complex of all such influences, and their separate analysis is impossible save on a purely empirical basis. We are not concerned, however, with the measurement of such abstractions as absolute fatigue, warming up, or impulse effects, but with the immediate question of how the individual responds to any experimental conditions demanding the continual exercise of a certain voluntary effort. In every individual and in every measure the factors that determine the course of the *Arbeitskurve* have a certain way of balancing each other, and the way in which this balance varies in different

individuals and under different conditions is the essence of the problem with which we are attempting to deal.

In a previous report, attention was called to certain anomalies in the work-curve especially associated with the retardation of manic-depressive depression.[1] In the present study certain of the more important of these cases, together with certain additional material, will be more fully presented from the standpoint of clinical analysis, and the correlation of the experimental results with the clinical pictures. Certain points in differential symptomatology also appear.

While the method and general experimental conditions are the same as those described in a previous contribution,[2] a brief review of them may not be out of place here. The subject begins at a given signal and taps at the maximum rate until a record of 30 seconds is obtained, when he receives a signal to stop. Then follows a 2-minute and 30-second pause, after which a second series is executed, then another 2-minute and 30-second pause, and so on until five series of 30 seconds, each with an intervening pause of 2 minutes and 30 seconds, have been obtained. A similar record of five 30-second series is then made with the other hand. When more than one experiment is made, the hands alternate in precedence from experiment to experiment, except as otherwise specified. In this form the experiment requires about half an hour to make, the greater part of which time is occupied in the pauses. This time can, of course, be much shortened by having the hands alternate from series to series, with a very much shorter pause, say 30 seconds, intervening between the different hands. For the first five or six daily experiments (50 or 60 series) the writer does not believe that this shorter form would, in normal subjects, yield different results from the form with the 2-minute and 30-second pause. In the present subjects, however, many of the points which appear of essential significance would have been much obscured by such a routine, so that this apparently uneconomical form of experiment seems to have more than justified itself.

The experiment is evaluated by counting the number of times

[1] Studies in Retardation, Am. J. Psych., XX, 1909, pp. 38-59.
[2] Am. J. Psych., XIX, 1908, pp. 437-439.

the key is struck and the circuit closed during each of the six 5-second intervals in each 30 seconds' tapping. The precise method of dealing with the data may be illustrated by quoting in full the figures of a single record (five series) with the right hand of a normal individual at the beginning of practice.

TYPE RECORD.

	1st interval 0″—5″.	2d interval 5″—10″.	3d interval 10″—15″.	4th interval 15″—20″.	5th interval 20″—25″.	6th interval 25″—30″.	Total number of taps in each 30″ series.
1st Series 35	34	32	33	32	32	198
2d Series 36	33	33	33	31	31	197
3d Series 36	34	34	32	32	33	201
4th Series 36	34	34	33	34	33	204
5th Series 38	38	36	35	34	34	215
Average of intervals..36.2	34.6	33.8	33.2	32.6	32.6	**203.0**

Each of the 30 two-place integers gives the number of taps executed in an interval of 5 seconds. Reading the top line from left to right, we obtain a gradual decrease in the size of the figures, indicating a slowing up in the tapping rate. The right hand figure of three digits, 198, gives the sum of the figures for the six intervals, i. e., the number of taps for the whole 30 seconds. Each successive line may be read in the same way. Considering the two-place integers in column, we obtain in the six figures of two digits and a decimal on the bottom line (36.2, 34.6, 33.8, 33.2, 32.6, 32.6) the average number of taps executed during the first 5 seconds, the second 5 seconds, etc. Naturally, a regular decrease is noted. The figure in heavy-faced type, 203.0, gives the sum of these six interval figures, i. e., the average number of taps executed each time during the five 30-second series. This figure is taken as indicating the " total efficiency " of the function in that record, subject, of course, to the variability of the single series it represents. Six successive 5-second *intervals* form a *series,* five 30-second series a *record,* and the two records of right and left hands constitute the single standard *experiment.*

An index of fatigue (f) for each record is obtained by dividing the average of the last five intervals by the average for the first interval. The average for first interval is 36.2, and the average for the remaining five is 33.6; the f, therefore, equals $\frac{33.6}{36.2}$, or .93. A high f indicates immunity to fatigue loss, a low f indicates susceptibility to it. If the f is above 1.00 it indicates that the favorable influences on the work-curve so outweigh those of fatigue that the performance of the five later intervals averaged actually better than the first interval. In normal individuals
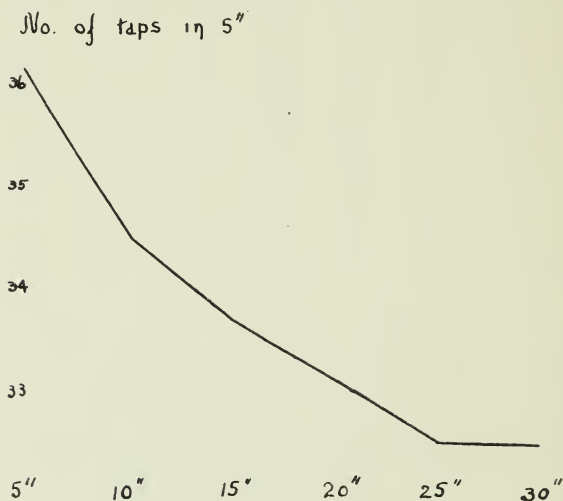

FIG. 1.

this practically never occurs; the normal f tends to fluctuate between .85 and .95.

There are, of course, many other features in the experiment, but in the present paper we shall be mainly concerned with this f, and with the character of the work-curve, of which it is an index. The fatigue-curve is plotted by joining together the points representing the average of five performances during each 5-second interval; thus the curve in the above-quoted record would run as shown in Fig. 1.

This gives, in each complete experiment, a curve for the right and a curve for the left hand. With normal subjects two experi-

ments are described, the work with the right hand preceding in the first experiment, and that with the left hand preceding in the second experiment. In speaking further of these records,
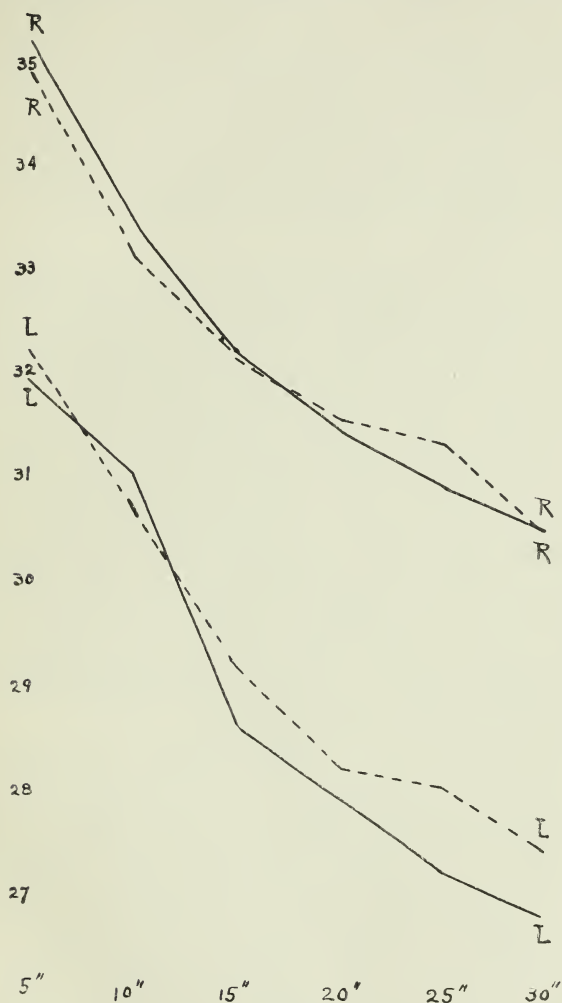

FIG. 2.

R_1 and L_1 will be used to designate those of the right and left hands in the first experiment; R_2 and L_2 the right and left hands in the second experiment. Where a greater number of

experiments are performed, the hands alternate in precedence from experiment to experiment. As it makes some difference which hand comes first, it is necessary to distinguish these experiments in the curves. The experiments in which the right hand precedes are sketched in a continuous line, those in which the left hand precedes are sketched in a broken line. The upper continuous and dotted lines naturally refer to the right hand, the lower to the left hand, except as otherwise specially indicated. According to this scheme of presentation, the course of the fatigue phenomena was found in 10 normal men to be as shown in Fig. 2.[a]

That is, the curves follow the usual form, the decrease in the rapidity of tapping being more rapid in the earlier intervals, and then slower. The f, or ratio of the last five intervals to the first, approximates .90 in each case, being a little higher in the right than in the left. We see that the hands are somewhat closer together in the second experiment than in the first, that is, the right hand is relatively better in the first experiments and the left hand better in the second. Each hand thus tends normally to be relatively better when it precedes than when it follows in the experiment. This relationship is markedly disturbed in some pathological cases, sometimes so much so that whichever hand precedes, it is always better (or worse) than the following hand.

In a typically retarded case of manic-depressive depression the curves shown in Fig. 3 were obtained.

These curves will serve to illustrate most of the peculiarities found in the records of the cases to be subsequently presented. Besides the lowered rate of tapping, the most striking abnormality is in the shape of the curve. This always drops very much less than the normal, and in the case of RI it even rises considerably. The interpretation of these delayed, or even negative fatigue phenomena, seems to be that assigned independently by Hoch, Specht, and Hutt, the progressive overcoming of the retardation. This we see most markedly in RI, where the curve is

[a] The results with a commensurate group of women were similar so far as the present comparisons are concerned. Cf. Am. J. Ps., XX, 1909, pp. 353-363.

almost the reverse of the normal. The first interval should normally be the best; here it is the worst. Whenever the performance of the first interval is surpassed by the performance
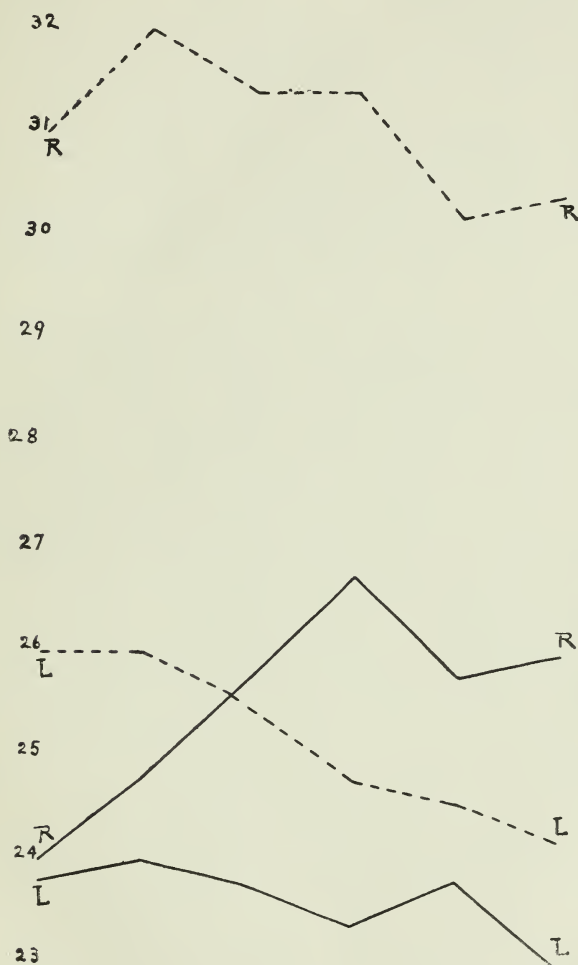

FIG. 3.

of a later interval, this will be known as *reversal*. Besides its conspicuous appearance in $R1$, *reversal* is seen less markedly in $L1$ and in $R2$, where the second interval surpasses the first. The

f's of all these curves are naturally very much above the normal, being as follows:

	R1	R2	L1	L2
Normal average	.90	.91	.88	.90
Typical depressed case...........	1.08	.99	.99	.96

It is also very striking how much faster the second experiment is than the first. Such a difference is, so far as I know, never observed in normal cases. The practice effect in two such experiments is negligible. There is thus indicated very much less retardation in the second experiment than the first, and this is confirmed by the fact that the curves of the second experiment (dotted lines) are much closer to the normal shape than those of the first. The right hand shows much less of the abnormal " reversal," the left none at all. We see, however, that the dotted lines are very much farther apart than the continuous ones. This here indicates the following hand to be the more favored, and is the contrary to what we find normally. It is as though the work done with the first hand helped to overcome the resistances to be encountered by the second hand. To this rather characteristic favoring of the following hand has been applied the name of *transference*. The lowered absolute rate and the abnormal presence of *reversal* and *transference* are the essential phenomena of retardation as given in the present results.

The principal source of error in these observations is imposed by limitations in material that are scarcely avoidable in the groups investigated. Whenever we wish to make a comparison between a normal and a pathological group, it is desirable that the groups be as similar as possible, save in the characters to be investigated; otherwise it is possible that other characters than those investigated are responsible for the peculiarities noted. The greatest difficulty is that of age. This objection applies with about equal force in the analogous experiments of Hutt and of Specht, and in those of the writer. Thus Specht's traumatic cases form a fairly homogeneous group, and so do his normal cases, but their averages are many years apart, the normal individuals being for the most part in the twenties, the traumatic cases well along in middle life. So here, the normal group would average about the same as that of Specht, the depressions probably somewhat older, and much more variable. Of how much this factor has influenced

the results, we can judge only indirectly. The phenomena do not seem dependent upon age within the normal or depressed groups, seeming in the latter, at least, much more dependent upon changes in the condition than upon age, nor are they sufficiently evident in equally old cases of other psychoses. The manic group, fortunately, is sufficiently homogeneous with the normal to be capable of direct comparison.

We may now proceed to study the results of the method in a number of special cases. Of cases I, II, III, IV, V, and VIII mention has been made in a previous study, *American Journal of Psychology*, Vol. XX, pp. 38-59. In this previous study they are respectively cases XII, IV, VIII, X, XI, and III.

2. CLINICAL HISTORIES AND EXPERIMENTAL RESULTS.

CASE I. On account of existing uncertainties as to the relationship of certain depressive states to psychasthenic conditions and to hysteria the following case, which can now with considerable certainty be assigned to the manic-depressive group, is perhaps of special interest. The patient is a man of 61, with some heredity, described as having always been a very nervous man. A six months' mental breakdown occurred at 38 and another at 40. Since then there have been no marked upsets until the present time, though he has been continually apprehensive and hypochondriacal. He would often get slightly depressed, but never sufficiently so to give up his work. Regarding these (*Abortivanfälle?*) he has said that it was " hard to concentrate his mind," " became very blue," " did not want to do anything," " all these attacks begin with a sense of ennui of work." The patient is a man of exceptional intellect and refinement. Physically, he has always been fairly healthy, though he mentions having had dizzy spells since childhood, and he has taken mercury and arsenic for an enlarged liver.

The beginning of the fixed ideas which color the present attack is referred subjectively to an episode about 18 months before admission when the patient, reading of a case of mercurial poisoning who had injured his family, began to fear a similar impulse. This fear became so strong that on one occasion he appealed to the police to restrain him, and during the latter part of this

period he remained away from his family, though wanting very much to be with them. During this time he underwent some hypnotic and psychoanalytic treatment with negative results, and there are recorded three ineffectual attempts at suicide. With this subject the regular experiment was performed four times; on August 19 and 27, and December 23, 1907, and February 24, 1908.

The first two experiments were performed within about a month after the patient's admission. In the first experiment the subject
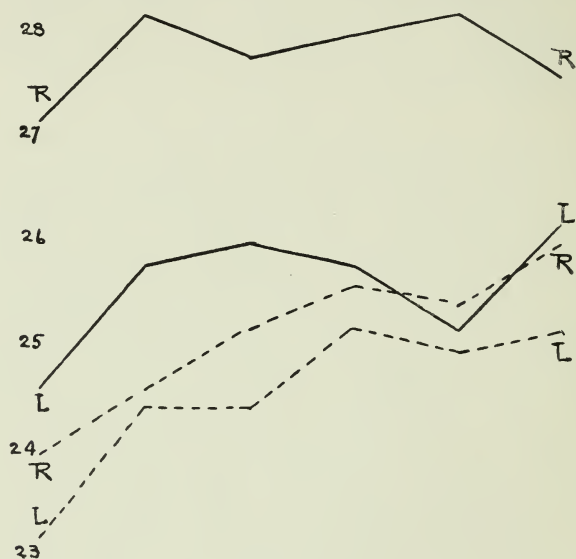

FIG. 4.

seemed to co-operate willingly, although expressing many depressive ideas, especially toward the close of the experiment, when he talked more. This experiment was made in the afternoon, while the experiment of a week later was made in the morning, and at this time he was more depressed. The curves in these experiments are as shown in Fig. 4.

These records, especially those in the second experiment, are as marked illustrations of intraserial warming up and reversal as the writer has observed. The first interval is always the worst, while in only one of the records is the final interval surpassed by an earlier one. For the period used, therefore, the

fatigue-curves are almost the reverse of the normal. The "transference" phenomenon is, however, altogether absent; if anything, it is the preceding hand which is more favored.

During the time up to the next experiment the patient was clinically noted to improve somewhat, and he began to occupy
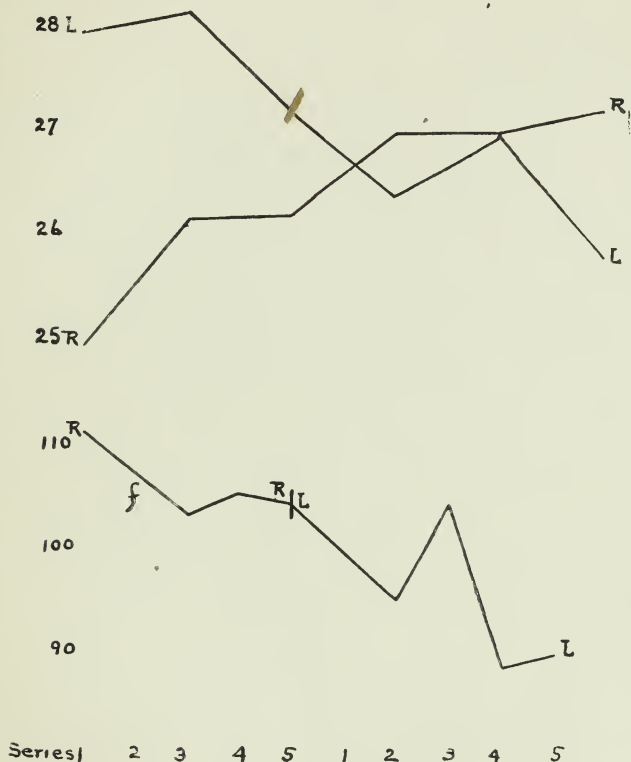

FIG. 5.

himself with various intellectual pursuits that interested him. A physician's note of his condition of January 1, 1908, reads in part: "The patient eats and sleeps well and takes a moderate amount of exercise, though a great deal of his time is spent in his room where he reads and writes. He is always cheerful and agreeable. He was granted parole of the grounds on October 23. Since then he has taken several trips to Cambridge with

his friends. These he invariably enjoys." A nurse's note made the day before the third experiment speaks of him as "doing well, seems more cheerful." We have apparently to do, therefore, with some progressive improvement in the patient's condition which may be compared with the difference in response to the test.

The curves in the third experiment, December 23, 1907, are as shown in Fig. 5.

The most striking feature of these curves is that the curves of the two hands are of a totally opposite type. The right hand, which precedes, shows a typically reversed curve, while the left hand, which follows, shows a curve much more approximating the normal, with reversal only in the second interval. It is to be noted also that while the left hand was inferior to the right in both previous experiments, it is now markedly superior to it. These phenomena indicate a considerable progressive change in the fatigability of the two hands throughout the experiment. The character of this change is best shown in the curve of the f itself, given below the rate curves for the two hands. It will be observed that regardless of the hand used, the f shows a progressive decrease throughout the two records. That is, the further the "resistances" of the depression are overcome by the work in hand, the more do the characteristics of the retarded work-curve disappear, and the more does the work-curve approach a normal character, with f's below 1.00. In the first two experiments the patient responded to these warming-up influences only within a single series, thus affording in both hands fairly typical reversed curves; but now, after a certain interval marked clinically by improvement in condition, the warming-up influence extends not only from series to series, but progressively throughout the records. An examination of the individual fatigue-curves shows how the earlier ones are typically reversed, and how this condition gradually changes over into the normal. The first curve of the experiment, made with the right hand, runs 25—27—27—28—29—29, f 1.12, a typically reversed curve; the last curve of the experiment, made with the left hand, runs 30—28—28—27—26—26, f .90, a typical normal curve. The apparent superiority of the left hand to the right is presumably a real "transference" phenomenon.

The points indicated in this experiment appear still more strik-ingly in the experiment made February 23, 1908.   When the
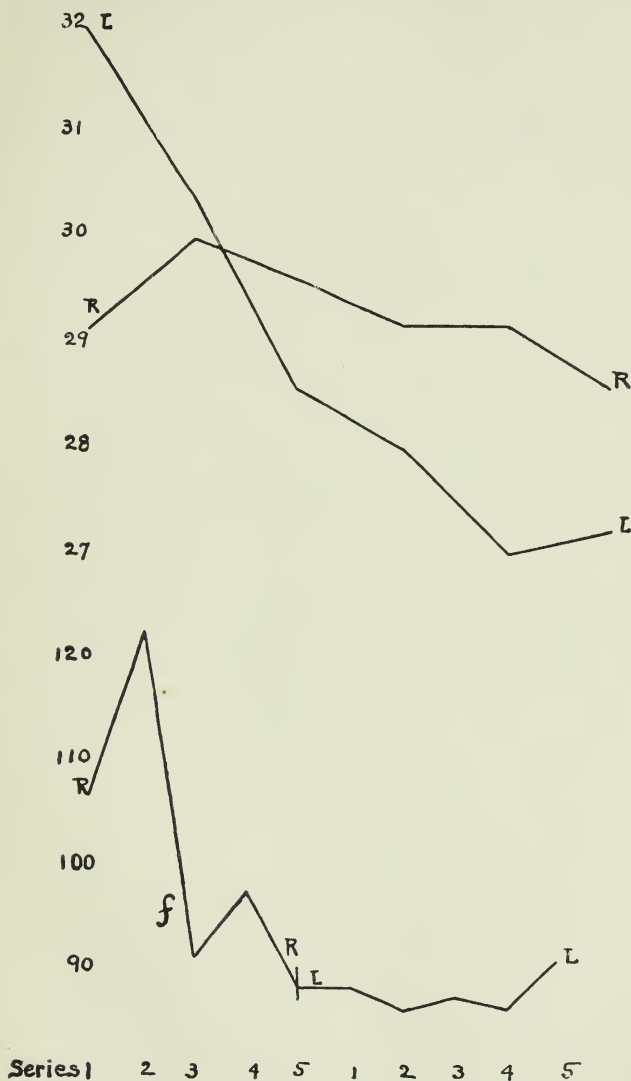

Fig. 6.

patient was sent for he was asleep, and had to be awakened to come to the laboratory.   On arriving there, although, as usual,

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entirely clear, he showed a depression and apprehensive manner not much out of keeping with his condition when first observed. This wore off during the experiment, at the conclusion of which he was quite smiling and talkative. The curves are as shown in Fig. 6.

We observe here a marked increase in absolute rate, which could hardly be associated with other than a changed condition of the patient. It is beyond the limits of both probable error and practice improvement. There is to a lesser degree the same difference between the preceding right and the following left hands as appeared in the third experiment. The right hand has reversal in the second interval, and shows very little fatigue; the left hand has no reversal, and even fatigues a little more than the normal. There is thus shown the same change in the conditions of fatigability, of which the curve of the f's again affords the best index. As in the previous case, this curve shows a progressive tendency to fall, though the fall is now confined to the first half of the experiment, while in the third experiment it persisted through the whole of it. Although this does not appear in the curves quoted, it should also be mentioned that the absolute rate of the five successive series now progressively increases in both hands, in the preceding right hand more than in the following left hand, whereas in the previous experiment this was evident only in the following left hand. The indications are that the patient is now much more susceptible to these warming-up influences, since they occur sooner in the experiment, and cover a wider range of improvement. The first right hand series is the slowest in all four experiments, with 133 taps, showing a curve with but slight reversal, which, however, persists throughout, 21—22—23—22—23—22, f 1.07. It is interesting to compare this with the second series, which in spite of its high f, 1.21, shows much less reversal. It runs 26—30—34—33—30—30; i. e., a low initial rate, quickly warming up to the maximum, and then fatiguing normally. After this the f's drop below 1.00, though the individual curves do not assume a normal character until the last right hand series is reached, running 36—34—32—32—31—31, f .89. The curves of the left hand are all perfectly normal, as the averages indicate, except that at the conclusion of the experiment there seems to have been a marked

Schlussantrieb. Superficially then, we had in this experiment a condition of depression apparently associated with the subject's just having been aroused from sleep, which, under the keying-up influence of the experiment (often very noticeable, even in normal individuals) gradually "swings over" into a condition in which the mood, at least, is rather hypomanic. The final series of this experiment are also not dissimilar from those obtained from manic cases.

The most reasonable interpretation of this case would seem to be that it is a manic-depressive condition which, owing to factors in the patient's make-up, is dominated by impulsive ideas. The depression is not secondary to the fixed ideas, but it is the fixed ideas which are secondary to the depression. This is further evidenced by the fact that the content of the patient's depressive ideas has recently changed somewhat and become more typical of what is ordinarily seen. The striking evidence of a motor retardation which these experiments afford throws an interesting sidelight on the fundamental character of the depressive symptoms.

CASE II. Market gardener, 65, some heredity. As a boy he was quiet and retiring, of a rather "artistic" temperament, learned well at school. Leaving school at 18 on account of illness, he went into business, his occupation being neither eventful nor exacting. The first attack occurred at 42, without cause, showing depression and inadequacy. It was mild and did not interrupt his work. During the next 16 years there were some half dozen similar attacks, which seemed to be followed by hypomanic states. Then attacks of three or four months began to occur every winter, characterized by depression, inadequacy, tendency to worry, and restlessness. These were also followed by slight exhilarations. The patient was admitted in the attack previous to the present, which was the sixteenth. At this time involution symptoms began to appear in exaggerated apprehensiveness and a restlessness occasionally "breaking through" the retardation. He was discharged very much improved after some six weeks, and got along fairly well at home for about a year, when he again became depressed, with delusions, suspiciousness and restlessness, and was readmitted two months later. He was entirely clear about his surroundings, but showed much inadequacy and self-accusation.

The regular experiment was performed twice. In interpreting
the records it must be borne in mind that the subject does better

FIG. 7.

with the left hand than with the right. The upper continuous
and dotted lines are thus those of the left hand. The curves are
as above.

The most striking point in these records is the difference between the first and the second experiments. The first experiment shows little abnormal in the shape of its curves, and its absolute rate is far beyond the limits of probable error above that of the second, which also shows marked evidence of intraserial warming up. As there could hardly have been such changes in superficial co-operativeness, the most natural indication is a change in the patient's condition. No such change can be traced in the clinical notes made independently of the experiments, though it was noted by the writer that the depression did seem somewhat deeper at the time of the second experiment. It would seem, then, that whatever the change in the patient's condition may have been, it was not one which was likely to be apparent to ordinary observation. The clinical notes speak of the patient's condition as fluctuating a good deal from day to day, but give no indication that this was one of his poorer days.

Very shortly after these experiments the patient left the hospital on a visit, and appeared very well for the first few days at home. Then delusional ideas began to return, coupled with restlessness and apprehension, which resulted in his return to the hospital some three and one-half months subsequently. Eight months later, a little over a year after the first two experiments, a third experiment was performed, whose results were very characteristic. The depression was deeper than at either of the two previous experiments. On being questioned a little when he came to the laboratory, his answers were very long in coming, but when they did arrive they were quick, sharp, and decisive. He was constantly fidgeting about, and showed very strikingly that the retardation was specifically one of the time of the outward reaction to the impulse, and not a matter of the absence or absolute feebleness of the impulses themselves. He denied feeling blue, but said he felt "bad." During the course of the experiment his general motor activity increased, and it was noted that he answered questions more promptly, and began a series of tapping sooner after the signal was given. Toward the end of the experiment he also spoke spontaneously. It was evident to ordinary observation that there was markedly less retardation at the end of the experiment than at the beginning. The curves are as below.

FIG. 8.

The simple curves for the right and left hands show little of significance. There is a tendency to reversal, which, however, is not maintained after the second interval. The undistinctive character of these curves, however, is due wholly to the fact that the progressive overcoming of the retardation already noted clinically, produces so great a variation in the individual series that in simply taking the average for the intervals the progressive changes are masked. The number of taps in each of the five individual series with the right and left hands is as follows:

NUMBER OF TAPS IN 30 SECONDS.

Right hand	93	62	82	81	99
Left hand	123	96	102	125	157

The characteristic in both hands is a relatively high rate in the first series, which drops to a minimum in the second, and then increases to the end. In each hand a low initial performance seems to be broken through by special influences at the beginning, after which the retardation again asserts itself, only to be overcome by the activities of the test. If we compare the relationship of the right and left hands in this experiment to their relationship in the other two experiments, there is evident a marked transference phenomenon, *i. e.,* undue favoring of the following hand. The left hand here averages half as fast again as the right, while in the previous experiments it was only slightly more rapid. The series in this experiment show a wider variation in rate than occurs in any other experiment the writer has made.

This variation is related in a rather significant way to the fatigue phenomena which the successive series show. The course of the *f's* through the successive series is plotted in the same way as for Case I. The *f's* begin low but at once mount very high, showing a great amount of reversal and then a gradual tendency to decrease to the end. Thus at the beginning of the experiment, at the period of greatest retardation, there was within the individual series no response to the warming-up influences at all, the first series running 19—16—14—15—15—14, *f* .79. Later, when the retardation is more overcome, we do find this response to intraserial warming up, obtaining such series as the fifth, with the right hand, running 14—15—18—18—18—16, *f* 1.22. Finally, the retardation is so far overcome that the best efforts

are put forth immediately with no delay in warming up, *e. g.*, with the fifth series in the left hand running 27—27—27—26—25—25, *f* .96, with no actual reversal at all.

These records illustrate especially a point in which the writer has quoted certain interpretations of Hutt.[4] The most profound conditions of retardation may present no response at all to the warming-up influences of the activities of the test, and a gradual overcoming of retardation is first seen in the ability to respond to these warming-up influences (as shown in the reversed curves), while, finally, the retardation being still further overcome, the fatigue-curve again more approximates the normal in form.

CASE III. Retired manufacturer, 71, some heredity. An industrious and hard-working man all his life, of best habits, retiring from business a few years ago, after he had made a moderate fortune. Although always having given a certain amount of his time to church work, at about this period he began to show excessive interest in religious activities that indicates the possibility of a hypomanic condition. Then matters went along about normally for a year, when three or four months before admission he was noticed to be sleepy, apt to lie down, slow to understand, lacking the power to start things. He also began to worry about financial matters, but no real mental cause of this or any other nature is known. For a brief period before admission he spoke openly of suicide. At the time of the experiments he was perfectly clear and oriented, and formed a striking example of those cases who, with a first attack at the involution period, yet show none of the characteristic involution symptoms, but form a typical picture of manic-depressive depression.

With this subject the regular experiment was performed 10 times, first on July 6, 1908, three days after admission; again on July 15, and daily for the eight days following. The averages of the six intervals are given in the curves subjoined, the experiments in which the right hand precedes being sketched in a continuous line, those in which the left hand precedes being sketched in a dotted line (Fig. 9).

The absolute rate is somewhat below the normal, and there

[4] Hutt: Rechenversuche bei Manisch-Depressive, Ps. Arb., V. 3 (1908), pp. 338-370. Wells: Studies in Retardation, Am. J. Ps., XX, pp. 49-50.

is considerably less fatigue loss than the normal, as is usually the case. On the other hand, except for those with the right hand preceding, the curves show no real reversal, but each individual curve runs along about on a level with no marked fluctuation. The subject co-operated with active willingness, and seemed always anxious to do his best; so that although there is no actual reversal, the curves probably present a real over-balancing of fatigue loss in the constant maintenance of a low but maximum rate.

The transference phenomena, which are the most striking experimental features of retardation in this case, are superficially
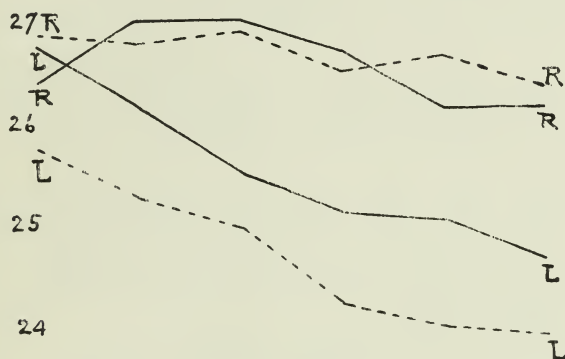

Fig. 9.

shown in the above quoted curves, the dotted lines being farther apart than the continuous ones, showing here that the following hand is the more favored. They are presented in greater detail in the accompanying curves (Fig. 10).

Bearing now in mind that on the odd days the right hand precedes the left, while on the even days the left hand precedes the right, the more favorable position of the following hand is evident. This is very seldom seen in normal individuals, except in a late stage of practice. In the curve for the index of right-handedness the index is invariably low (*i. e.*, the left hand relatively poorer) when the left hand precedes, and high when it follows; on the fifth day the right and left hands were exactly equal. With the sole exception of the last day, the index rises

on the odd, and falls on the even days. This result corresponds closely to that obtained by Hoch in a similar case with the ergograph (*Psychol. Bull.*, I, 255). With respect to *f* the left hand is
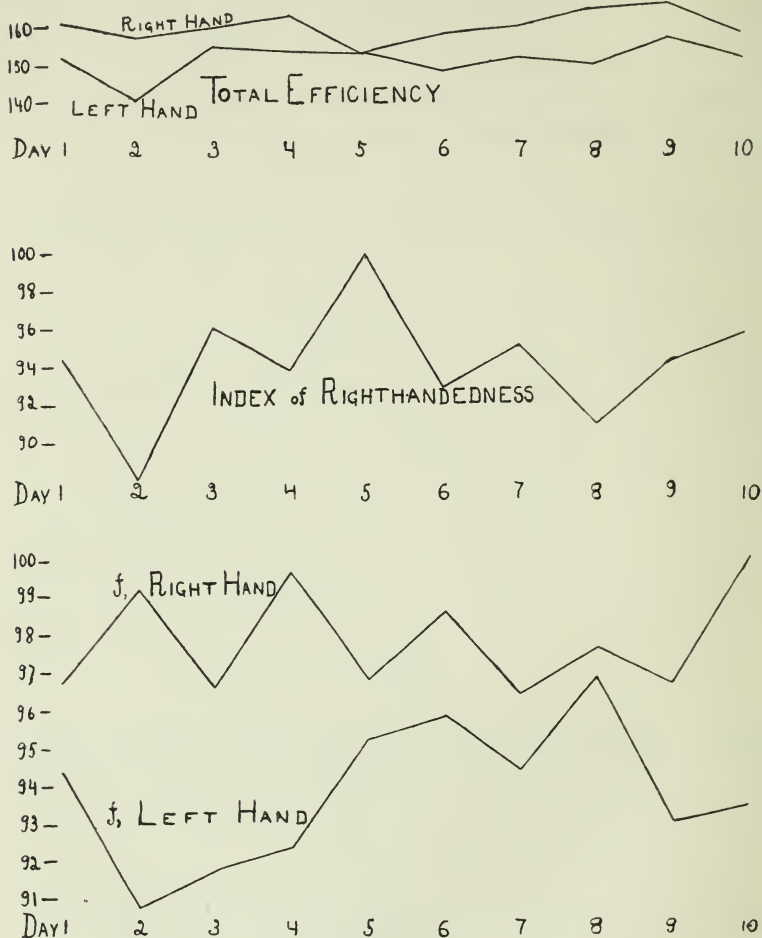

FIG. 10.

subject to a certain constant influence that may be in the nature of practice effect, but the alternation of the right hand *f*'s is perfectly clear cut. They are high on the even days when the right hand follows, and low on the odd days when it precedes. Such warming-up effect, then, as is transferred from the pre-

ceding left to the following right hand, shows itself in a greater immunity to fatigue in the right hand; when it has not this warming-up influence behind it, it is distinctly more susceptible to fatigue losses.

In the curves of the total efficiency from day to day, one can trace the same relationship of the right and left hands that the index of right-handedness shows with more fidelity; but it is necessarily obscured by the intercurrent changes in the patient's condition. The writer made a brief daily note of the patient's apparent condition (before evaluating the experiment, of course), the main points of which are as follows:

1. July 9. Patient clear, did not seem much depressed, but expressed spontaneously a feeling of apprehensiveness as distinguished from depression.

2. July 15. Did not seem to take as much interest as previously. Seemed rather more depressed. Spoke spontaneously twice.

3. July 16. Mentioned spontaneously feeling a little more cheerful, as he had been doing some things in which he was interested. Made an adjustment in the apparatus of his own accord. Walked about the laboratory afterwards, examining apparatus.

4. July 17. Said he felt worse than day before, and, in general, seemed more depressed.

5. July 20. Subject about the same. Cannot lie down to rest on account of the depressive ideas that come on him at such times.

6. July 21. Subject felt a little better than usual, according to his own statement. Did not talk so much.

7. July 22. Talked a good deal more freely. Subjective condition better than previously. Spoke of a certain series (wrongly) as the best yet.

8. July 23. Felt worse than day before, did not talk so much.

9. July 24. Subject mentioned feeling "alert" in contrast to usual "numbness"; more alert to-day than at any previous time. Thought was doing better. Talked depressively, but a good deal.

10. July 25. Not nearly so "alert" as day before. About as usual.

The nurse's notes, covering this period, contain nothing contradictory to the above observations. It should be mentioned that these memoranda are derived mainly from immediate observation of the subject, only secondarily from the subject's introspective account of his condition. It is rare, indeed, that a depressed patient will admit feeling better until recovery is far advanced; they often struggle against such an admission, long after improvement is clinically evident.

As we should expect, there is indicated a tendency for the gross rate to be higher on good days, and lower on poor ones. The two extremes of condition, the second and ninth days, are marked by, respectively, the worst and the best performances in the test. For the other days there is nothing special to note, except that on the seventh and tenth days the apparent *change* in condition was sufficient to affect both hands in the same direction; the curves usually run in opposite directions owing to the transference of " warming up."

While the series made on a single day vary less, the day-to-day variability in this subject is a good deal more than the normal, and there may also be noted the absence of practice effect. It seems to be a frequent observation with pathological subjects that susceptibility to practice (*Uebungsfähigkeit*) is decreased, but this is probably secondary to inferior co-operation, the normal practice improvement demanding a degree of doing one's best that is probably never attained in this class of subjects, even under the conditions of greatest apparent willingness.

The following figures give the averages and m. v.'s of the quantities expressed in the foregoing curves, classified according to the preceding hand:

	Index of right-handedness.		f (rt. hd.)		Gross rate rt. hd.		Gross rate lft. hd.	
	Av.	m. v.	Av.	m. v.	Av.	m. v.	Av.	m. v.
Right hand preceding	.960	.018	.966	.001	159.5	2.9	153.3	2.0
Left hand preceding..	.925	.022	.989	.006	159.9	1.8	148.2	2.4

The differences in favor of the following hand are small, but save in one case well beyond the limits of probable error.

CASE IV. Machinist, 59, heredity unknown, grammar-school education. The case is one of rapidly recurring and rather short depressions recurring at intervals of about two years, since their

commencement at 37 years of age. The attack in which the
present experiments were made is much the longest of them,
having lasted with one slight remission for nearly two years;
the patient was well on the road to recovery at the time of making

FIG. 11.

the experiment, and has since recovered and gone into another
depression. There have been no excitements.

Two experiments were performed on succeeding days. On
the first day the patient made a fairly normal appearance, co-
operating willingly all the while, though seeming to brighten up

somewhat during the experiment. This experiment took place at 3.30 p. m. The following one was arranged for 10 a. m., and it was arranged that the patient should be left quiet up to this time, with the not unexpected result that the patient's mood was considerably less cheerful at this experiment. The records also reflect a characteristic change in the motor sphere, being as shown in Fig. 11.

As in Case III, there are no clear-cut phenomena of reversal, though the f's are considerably greater than the normal. On the other hand there is much greater fatigue loss in the second experiment (dotted lines) than in the first; that is, the individual series show the greater susceptibility to fatigue at the time when retardation is objectively the most prominent, just as did the earlier series of the third experiment with Case II. The most abnormal feature of the records is again, however, found in the transference phenomena. In the first experiment, performed in the afternoon, the right hand record averages somewhat below normal; but the left hand, which follows the right, is much above normal for the left hand, and even considerably surpasses the performance of the preceding right hand. In the second experiment the left hand, which now precedes, has the poorest record of all, but the right, now in the favored position, is much better than the left, though it does not reach its average of the previous day. We thus have an immunity to fatigue and a transference effect above the normal, with a drop in gross rate and increased susceptibility to fatigue associated with an objectively given poorer condition.[5]

CASE V. Market salesman, 55, a slight heredity. As a boy, bright and active, learned well at school, which he left at 15 to work in a store. He was quite successful in business, though when about 45 he had a financial setback that gave him considerable anxiety, which, however, he threw off well. During the last few years he has also worried somewhat over dulness in the market.

The present trouble has its origin in a railroad accident, which

[5] Cases IV, VI, and XI were patients in the Boston Insane Hospital. For access to these cases and for their histories grateful acknowledgement is made to the officers of this institution.

made him a cripple and necessitated two surgical operations. The shock of the accident and the main operation he bore well, and kept in good spirits until the second, a relatively minor operation, when he became progressively very much depressed, growing nervous and irritable, easily disturbed at the slightest noise. Then hypochondriacal delusions began to develop, and there was an attempt at suicide, after which he became more depressed, and
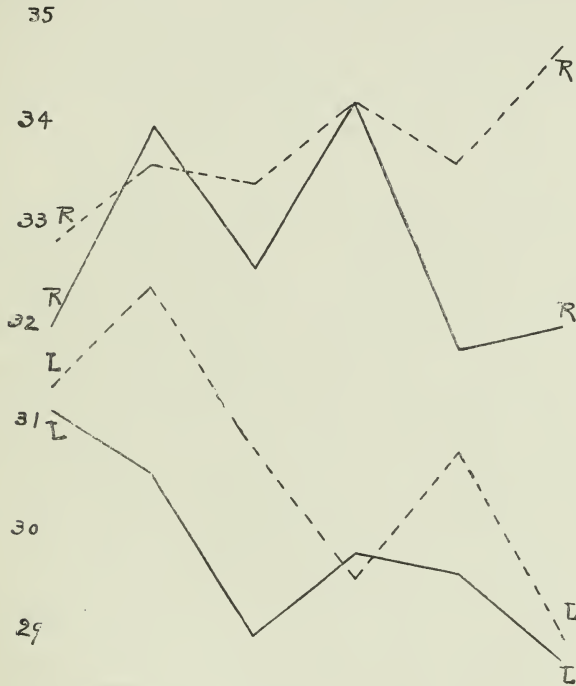

FIG. 12.

was removed to an institution. On admission to the McLean Hospital, 17 months after the onset of the psychosis, the patient was restless, irritable, hypochondriacal, complaining of great fatigue. He mentioned feeling worse *at night*. Some improvement was noted during the next month, after which his condition remained about stationary. Two experiments were performed about 15 months after the patient's admission, the curves running as shown in Fig. 12.

It is interesting to note that in spite of the fact that this pa-

tient complained greatly of the exhaustion induced by physical effort, he actually showed a little better performance than the normal, and this precisely because of an almost absolute immunity to fatigue losses. The right hand shows a considerable amount of reversal, the curve of the second experiment being more typically reversed than that of the first, though the f is equal in each record. The left hand also shows more tendency to reversal in the second experiment than in the first. There is no transference phenomenon, nor is there any objective change in the patient to which might be referred the fact that the second experiment, besides showing more overcoming of retardation, averages from five to six taps better than the first, and is also much more constant.

The records in this case correspond quite closely with those obtained in the sixth subject of Specht (Vp. M.).[a] This subject, an entirely typical traumatic case, differentiates himself markedly from Specht's other subjects in showing a progressive increase in the efficiency of performance exactly comparable to that noted in the case above. Specht also attributes this to *Hemmungswirkungen,* which the course of the experiment tends to overcome. He writes: "Die Hemmung . . . . ist hier im Beginn der Arbeit grösser als im weiteren Verlauf; sie schwindet nicht, aber in ihrer Wirkung auf den Gang der Arbeitsleistung wird sie durch die arbeitsfördernden Einflüsse der Uebung und möglicherweise auch der Anregung abgeschwächt." The present result would seem to point to this interpretation in the case of Specht's subject, M., as the correct one; at any rate, this subject represents a totally different fatigue condition from his remaining five subjects, and one which corresponds much more closely to that observed in manic-depressive depressions with the tapping test here, and with the addition test itself by Hutt. However, the clinical data given by Specht mention nothing in favor of a manic-depressive condition for this case. In the present subject the diagnosis was more doubtful. There was a far from positive history as regards previous attacks, and this, coupled with the obvious origin of the symptoms, together with irritability and complaint of exhaustion, pointed to a traumatic neurosis. On the

[a] Specht: Ueber klinische Ermüdungsmessungen, Arch. f. d. Ges. Psych., III, 1904, pp. 316-318.

other hand, there were no anæsthesias or paræsthesias, and the presence of a thinking disorder and inadequacy pointed at first in the direction of manic-depressive. The further history of the case, which has failed to improve, indicates that clinically it satisfies better the present conception of a traumatic neurosis.

There are, then, two possible interpretations of these two cases: If the normal situation in traumatic neurosis is exceedingly great fatigability, as Specht has found it, and the manic-depressive depressions are apt to exhibit reversed curves, as Hutt and the writer have found, the indications for these two subjects are rather in favor of a psychosis upon a fundamentally manic-depressive basis, but with a more or less accidental traumatic coloring. There is the alternative possibility that traumatic cases may occasionally show the same phenomena of retardation as the manic-depressive, without its having any further influence on the clinical picture.

CASE VI. From a differential standpoint, this is perhaps the most interesting of the cases presented. The patient is a man aged 20, no occupation, slight heredity. As a child he seemed to be perfectly normal, but did not get along well during the latter part of his school life, being unable to keep up with his classes, and has of late been growing " nervous." For the past three or four years he has had an enormous appetite. About six months before admission he became very restless, moved about quickly, would tip over furniture, and so on, and kept constantly on the move, though he sometimes assumed strange positions. About three weeks before admission he said that he saw his father, who had been dead for six months, and for two weeks previous he destroyed his clothing and was very careless in his habits. He was noted to talk to himself.

When first seen by the writer his appearance was downcast and melancholy. He would hardly answer questions at all, and then only very slowly and briefly. He said that he felt blue. When asked if he felt better any particular time of the day he said that he felt better in the afternoon. The immediate picture was one of depression rather than one of apathy, suggesting the more frequent condition in youthful manic-depressive cases, in which the retardation tends to outweigh the affective depression, and his conduct during the experiments was in conformity with

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this interpretation. He did not speak spontaneously, and from the time of the experiments until he was next seen he was reported not to have spoken at all. At this time he came into the room slowly, looking not so much depressed. Asked if he had ever seen the speaker before he replied, " Yes." " How long ago was it?" " About two weeks—no, longer; it must have been five or six weeks ago." (Approximately correct.) Asked what he did at this time he said, " Tapping," also making the motion with his hand. He then lapsed into his former inaccessibility, sitting immobile, with head hung down, and nothing further could be gotten from him.

Clinical notes of the patient's condition at and about this time are as follows: " The patient has a dull facial expression. He sits about in a dull, apathetic manner. The saliva drools from his mouth, and he remains in fixed attitudes for long periods of time, is very resistive, and does not dress or undress himself, and at times shows considerable negativism. Occasionally there are times during which he is active, and during these spells he does undress himself and tears his clothing." This covers the patient's condition during September, October, and November, 1908. During December he is reported to have shown considerable improvement. " There is at present considerable retardation of both psychical and physical activities, but he is able to answer questions fairly well. Memory and orientation seem to be quite good. He has taken on considerable flesh of late, and is gradually becoming more active and doing some light work about the ward." Three months later: " The patient continues to show a slight, gradual improvement. At present he takes considerable interest in his surroundings, reads the newspapers, has parole, and does considerable work about the ward. Some retardation exists in his mental and physical condition." And again, a month later, " The patient is showing gradual improvement, is at present doing some work about the grounds, but is rather slow in all his movements, and does not show a normal amount of interest in his surroundings. There is some retardation of both mental and physical activities." [6a]

[6a] Since this time the patient has been at home, where he was seen a few days before the present writing, but the data obtained still leave diagnosis doubtful.

So that, as between manic-depressive depression and dementia
præcox, we have a previous history that speaks strongly for
dementia præcox, a picture at the time of the experiments that
showed traits both of a manic-depressive and of a præcox nature,
and a course that is much more characteristic of a manic-de-
pressive condition, but by no means excludes dementia præcox.

FIG. 13.

The overshadowing characteristic of his condition at the times
when he was observed was the slowness and inefficiency of his
responses, and the essential point is whether this slowness and
inefficiency represented an extreme lack of affective reaction, or
if it was the product of a specific retardation of the motor func-
tions. Regarding this question the curves shown in Fig. 13 give
some rather significant testimony.

These curves stand considerably closer to what has been observed in manic-depressive than in præcox conditions. The gross rates are below the normal, the $f's$ are high, and there are distinct phenomena of reversal, these being in each case more prominent in the following hand, *i. e.,* the left in the first, the right in the second experiment. It may also be noted that in the first experiment the preceding right hand is much poorer than the left. In the second experiment the following right hand is much better than the left; indeed, the transference phenomenon is in this case more striking than in any other subject observed, save in the third experiment with Case II. The abnormalities in these records are distinctly those associated with manic-depressive depression rather than with dementia præcox; indeed, it is quite doubtful whether dementia præcox cases show any consistent abnormality in the tapping test. In the presence of a specific motor retardation the case has certainly run a very different course from the usual dementia præcox cases, in whatever diagnostic group the case may fundamentally belong.

CASE VII. This case and the following are depressed states showing clinically considerable retardation, but with factors in the history indicating the possibility of one of the protean forms of general paralysis. The patient was a man of 41, veterinary surgeon, no heredity. As a boy, he showed unusual mental ability, and he has always been a hard worker, physically strong, with no serious illnesses except for a history of syphilis. There is also a history of some nervous breakdown three years before admission, from which it is not certain that there was complete recovery, but which did not interrupt his work. The symptoms definitely related to the present illness began about a month before admission. He seemed to be losing interest in his work, would often be very irritable, and quickly get over it again. Appetite and weight were falling off. There were no known fainting attacks nor seizures. Physical examination was negative, though lumbar puncture showed a marked excess of small lymphocytes. The experiments were performed about four months after admission, and the patient remained under observation for about 10 months after this, when he was transferred, his condition remaining practically stable up to the present. During observation he

was fairly clear, his memory was good. No great emotional
depression was evident on the surface; the one prominent and
fundamental symptom seemed to be a marked and typical retarda-
tion. The curves are as below.

Fig. 14.

The curves are remarkably inconstant in form. The second
experiment shows much less fatigue than the first, and the left
hand much less than the right. One of the records shows con-
siderable reversal, but the individual series are very irregular,
and the statistical correspondences with the certain manic-depres-

sive records are quite likely to be a product of chance. There are a good many failures of innervation, as long periods of pressure and release, and these seem to be more marked in the earlier portions of the series. The performance is distinctly a pathological one, but it is more similar to what has been seen in coarse neurological conditions, and it seems to give little evidence of the clinically apparent retardation.

CASE VIII.   A man of 42, merchant, bad heredity. Was bright and active as a boy, of good habits and learned well. He went to school until 18, since when he has been in business. He has applied himself very closely to his work, hardly ever taking a vacation, was not thought of as a nervous man, and has shown good business ability.

The present attack, which is the first, seems to date back to some self-accusatory ideas which the patient developed regarding the fatal illness of a relative to whom he was much attached. He began to sleep poorly, and about five months later went to an institution, where he was mostly unoccupied, at times resisting the efforts of the nurses to get him out of doors, though he was not violent nor suicidal. His sleep improved. When transferred to the McLean Hospital he was rather depressed, unoccupied, showed no interest, not speaking spontaneously, but answering questions, and was oriented. He remained under observation a little over a year, during which time his mental condition remained about the same, perhaps showing a slight improvement, and again a relapse shortly before his removal, since when his condition has been practically stable. The present tests were made a little over two months after admission, the curves being as shown in Fig. 15.

No pathological element appears in these records. The gross rate is somewhat above the normal average, but not abnormally so, and the same is true of the susceptibility to fatigue. There are certain characteristics in the experiments that usually appear in normal individuals only after some practice, though no history of such practice was obtained. Although the second experiment is slightly inferior to the first (as is usually the case with normal individuals), the clinical notes indicate a slight improvement in the patient's condition during the week between the experiments. Whatever may be the correct diagnosis in these two cases, the

results strongly indicate that there is a type of retardation in which the motor work-curve is not affected in the same way as in the more characteristic retardation of manic-depressive depression.

FIG. 15.

CASE IX. It is, of course, a clinical commonplace that retardation is not a necessary accompaniment of emotional depression; various conditions are seen in which the depression is accompanied by considerable activity, as in the mixed states of manic-depressive insanity or in involution melancholia. From this point of view the

records of three agitated depressions may be presented for comparative purposes. The first of these is a man of 58, bookkeeper, no heredity. He learned well at school, and after a short period as a bank clerk became a bookkeeper, holding a single position for the 30 years preceding his illness. It seems that a year or two previous to this attack his ability had been falling off, but the acute symptoms began when he was summarily discharged from the position, possibly because of his loss of efficiency. Before admission to the McLean Hospital he had been 18 months in another institution, and the present experiments were made just one year after admission. Nearly a year has elapsed since this time, during which the patient's condition has not changed materially. He presents uniformly a typical involution picture, showing anxiety, agitation, "moral pain" but not self-accusation, suicidal tendencies, and a good deal of motor activity and restlessness.

The usual experiment was made 10 times. Co-operation was exceptionally good, the patient often seeming to go at the test as a temporary substitution that might distract him for the moment from his depressive ideas. During the pauses he would often grow impatient to begin again. Ten experiments were made, on successive days, the right hand preceding on the odd days, the left hand on the even days. The curves, calculated in the same manner as for Case III, p. 24, are as shown in Fig. 16.

The gross rate is somewhat, not markedly, below normal, while the f is just normal. There is no evidence whatever of a motor retardation in the shape of the fatigue-curves. If the records are examined with reference to a transference effect from one hand to another, it will be seen that each hand is relatively better when it precedes than when it follows. This is seen in normal subjects, but the phenomenon in this case is much more marked; it is the precise opposite of the transference that is seen in manic-depressive retardation. Its character is illustrated in the curves shown in Fig. 17, which are plotted in the same manner as those for Case III.

The curves of total efficiency and for the index of right-handedness run in precisely opposite directions to the corresponding curves in Case III, who, it will be remembered, was a case

showing a first attack, at the involution period, of a typically
manic-depressive character. In the present case the curve of the
right hand rises on the odd days, when it precedes, and falls on
the even days, when it follows; while the curve of the left hand
falls on the odd days, when it follows, and rises on the even days,
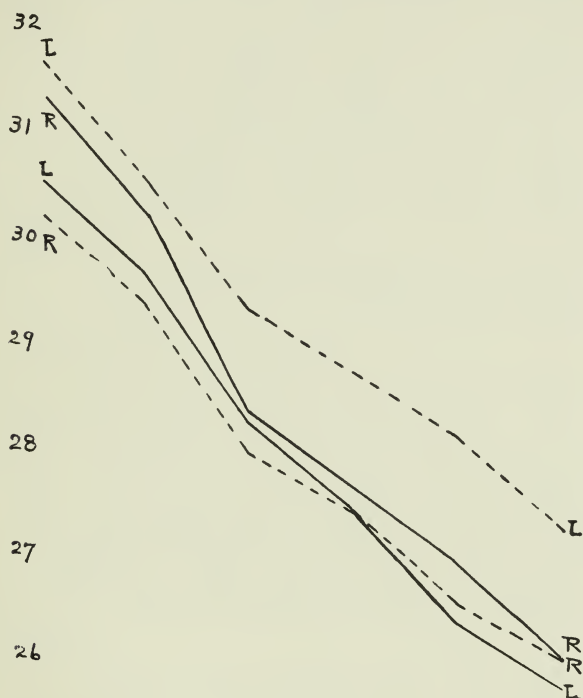when it precedes. The index of right-handedness shows again

FIG. 16.

a precisely opposite alternation from that of Case III, but the
fatigue phenomena show nothing of significance.

It will be remembered that in Case III it was possible to trace
a certain correspondence between the total efficiency curve and
the fluctuations in the patient's condition. In the present case there
were fluctuations in the patient's behavior even more marked than
those noted in Case III, but they have left absolutely no trace
on the results. These fluctuations consisted in a cyclic exacerba-
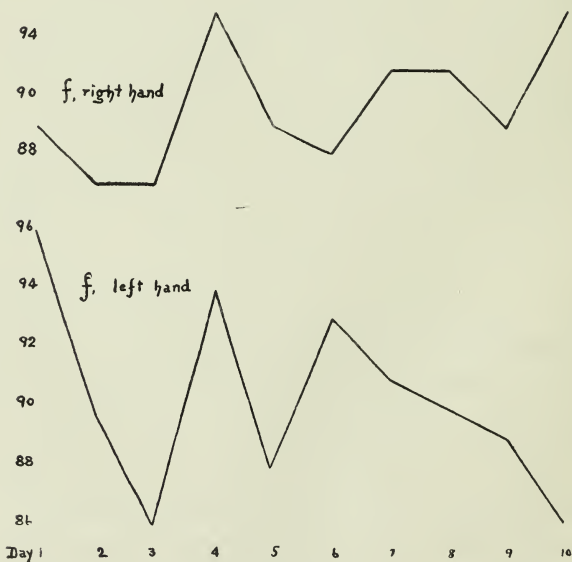tion and subsidence of the agitated symptoms on alternate days.
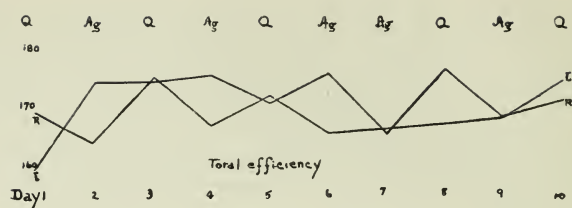
FIG. 17.

This may be illustrated by the brief daily notes of the patient's attitude, running substantially as follows:

October 12, 1908. The subject entirely co-operative. Agitated and depressed but quite clear, and talks a little on general subjects, asking for example about the possibility of the Bulgarian tangle resulting in a European war.

October 13. Much more active and apprehensive and less clear than yesterday. Talked unceasingly, begging to be released. Complained that his breathing was painful and that his bowels were paralyzed. Was impatient to begin every fresh series.

October 14. Not so agitated as yesterday nor so calm as the day before. Did not ask to be released. Asked questions and made remarks spontaneously on various subjects, these giving rather the idea of an attempt to get away from the background of the depression.

October 15. Very much agitated, with continual motor activity. Begged to be allowed to go home, offering the experimenter $10,000 to recommend his discharge.

October 16. Very quiet, more so than at any time during the experiments, hardly spoke at all, except to himself.

October 17. Agitated, a good deal of motor activity, and apparently more " moral pain " than at previous interviews.

As it was reported that this alternation of quiet and agitated days was a regular occurrence with the patient, no experiment was made on October 18 in order that the same precedence of the hands in the experiments should not be confined to depressed or agitated days.

October 19. Very much agitated, more active than at any previous time. Paced the floor continually, offered the experimenter $1000 an hour to let him go home for 48 hours. Also tried to induce the nurse to aid in his escape.

October 20. Quiet, did not get up out of chair. Not nearly so agitated, and showed more ability to rise above the depression.

October 21. After the second series paced the floor continually, twice tried to get into a drawer where sharp instruments were kept, and made requests similar to those above noted about going home.

October 22. Patient quiet. Condition substantially similar to October 20.

The tapping test is ordinarily quite responsive to such changes in condition as are reflected in the behavior here, and its failure to be affected by them in this case is surprising. It may be mentioned that while the patient actually does considerably better with his left hand, he said that it was easier for him to perform with his right, and he also said he thought he did better with it. Though the difference is slight, the preferred hand shows in the

FIG. 18.

long run the greater immunity to fatigue, as we are accustomed to find.

CASE X. A man aged 78, retired merchant, some heredity, early history negative. He was successful in business, from which he retired at 63 on account of " nervous prostration." For about five years before admission he was somewhat eccentric and inclined to be ugly toward his family, but about a month before admission his attitude changed and he became very affectionate. This lasted for about three weeks, when one night he performed a number of eccentric actions, finally culminating in a feeble

attempt to kill his wife. When it was suggested that he should come to the hospital he was at first willing, but later became irritated and uncontrollable, and escaped from the house to a pond where he made a weak attempt to drown himself. Here he presents a picture of irritability, a few feeble persecutory delusions, and a tendency to malingering, but with alertness and no marked memory defect. Two experiments were performed about six weeks after admission, the results being as shown in Fig. 18.

The gross rates are distinctly above the normal and there is neither reversal nor favoring of the following hand. The right hand fatigues very little, but there is partial disability in the right arm, due to its once having been broken, so that what we have here may be analogous to the latter part of the fatigue-curve, the higher initial rate that we should have had being lost. The left hand begins at about the same level as the right and fatigues normally. These records thus show no evidence of a motor retardation.

CASE XI. A printer, aged 47, bad heredity; has used a great deal of alcohol. The present attack is the seventh. Between the previous attacks he has cleared up sufficiently to work, but his intemperate habits doubtless help to throw him into the successive depressions. The present condition is characterized by considerable emotional depression with delusions. He is always on the move, though his movements are not especially rapid or efficient. He does not speak, but keeps up a low moaning to himself. However, he understood what was wanted in the experiments with surprisingly little difficulty, and co-operated exceptionally well, seeming, like Case IX, to go at the test as a sort of " substitution." In the ward he wore mitts to keep him from tearing his clothing, which were necessarily removed for the experiments, and the entire time of the pauses he would spend picking at himself unless restrained. Two experiments were performed, the second two days after the first, the fatigue-curves being as shown in Fig. 19.

Only one of these curves, that of the right hand in the first experiment, shows an abnormal immunity to fatigue, nor is there sufficient evidence of transference to afford any certain criteria of motor retardation in these records.

The method then fails to demonstrate in these three cases the usual phenomena of retardation, in spite of the fact that the last considered case should probably be assigned to the manic-depressive group in any but the narrowest acceptation of the term.
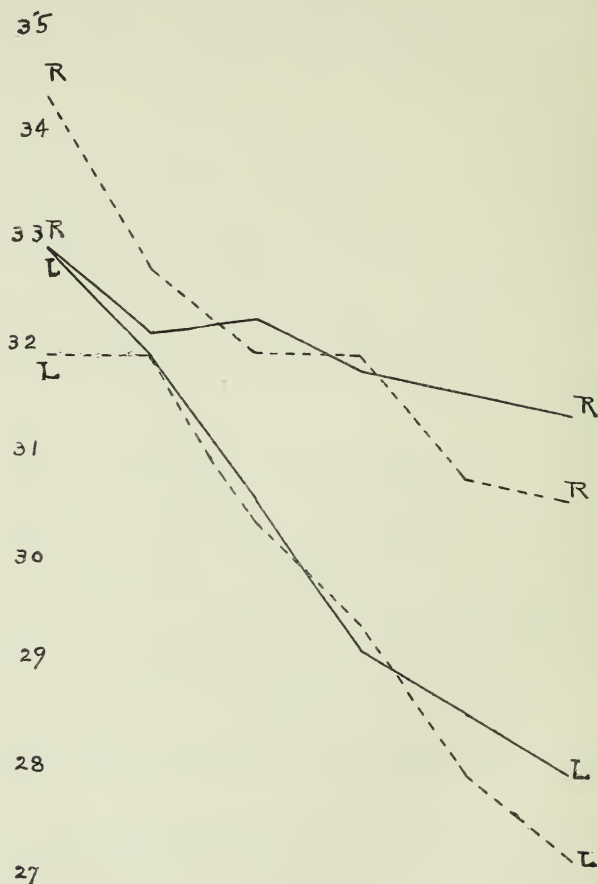

FIG. 19.

3. GENERAL CONCLUSIONS.

In order to compare the average performance in the tapping test of normal and depressed individuals, as well as the performance in diagnostic groups in whose symptomatology retardation

does not play a fundamental part, the accompanying figure is presented. This gives the average fatigue-curve in 10 normal subjects, seven manic subjects, six cases of dementia præcox, five of general paralysis, and, finally, that of the 10 manic-depressive cases presented in a previous study. While the individual cases, of course, vary considerably about these averages, it is doubtful
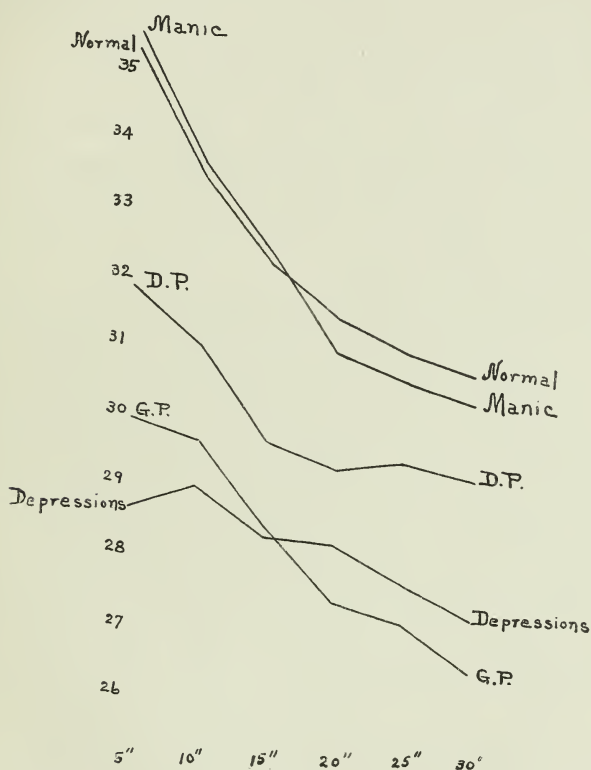

Fig. 20.

if the significance of the results warrants their more detailed presentation in this connection. The principal point in this figure concerns the relation of the manic performance to the depressed.

The results of the manic cases indicate a maximum rate distinctly above the normal. In the cases which showed a real manic excitement the maximum rate was considerably higher, but the average is brought down by two cases who showed a rather

easy-going euphoria, and co-operated with more willingness than zeal. The curve remains somewhat above the performance of normal subjects until half way through the work period, when it drops somewhat below it. Compared with the normal cases, the manic thus show a higher initial rate and a greater susceptibility to fatigue. In the isolated cases in which it was possible to observe the behavior of the test with respect to changes in condition, it seemed also that the more manic states had the higher initial rate with the greater susceptibility to fatigue.

The average curve of the depressed states, on the other hand, shows a very slow initial rate with a slight reversal in the first interval, which then fatigues very gradually through the rest of the work period. The work-curves of the manic and depressed states are thus found to be both in amount and character on opposite sides of the normal.

Franz, using two normal, two depressed, and two manic subjects in various psychological tests, did not find any consistent superiority of the manic performance over the normal; indeed, the manic subjects were apt to be rather inferior to the normal, though not so much so as the depressions. Hutt, however, using the fatigue-curve of the addition test again found the manic performance to be somewhat superior to the normal. On the other hand, while there is in the tapping test observed an increased susceptibility to fatigue, Hutt found that manic cases would gradually increase in rapidity in the same manner as the depressions. There are features in the manic state according to which either of these results can be interpreted. Hutt classes the increased manic efficiency with the increased excitability under stimulation clinically noted in these cases; the abnormally rapid loss in efficiency found in the present experiments corresponds rather to the suspended inhibition of manic cases, leading to the putting forth of greater initial effort, and consequently the more rapid wearing out of the organism. The explanation of the difference probably rests in the character of the experimental task, and the different levels of neural activity which are involved. Objective motor fatigue is generally admitted, while the nature or even the existence of intellectual fatigue is still somewhat in dispute.

Working with the eye movements over a wide range of cases,

Diefendorf and Dodge[7] found the angular velocity in manic cases distinctly superior to the normal. On the other hand, the simple reaction time, as well as the pursuit reaction, was found to be slightly shorter in the normal than in the manic cases. It may be noted, however, that in these two functions the greater distractibility and inferior attention of the manic cases would operate more to their disadvantage. This perhaps explains why, though the manic states are worse, the "hypomanic" are better than the normal in these two functions; the distractibility would be less here and the attention better. They are, however, not quite so quick in simple reaction.

It is the prevalent clinical opinion that the greater superficial activity in the manic state is to be interpreted not as the greater efficiency of the nervous impulse but as the removal of the inhibitions it ordinarily has to overcome. This fact does not itself justify the secondary interpretation sometimes made that psychic capacity is fundamentally decreased in the manic state just as truly as in the depressed. Every clinician of experience is familiar with cases who make much better superficial impressions, and who in some instances may be actually regarded as more efficient members of society when they are hypomanic than when they are normal. The potentiality of the more efficient reactions is there, but they are normally restrained by inhibitions which the hypomanic condition removes. Thus the taciturn individual who becomes an excellent conversationalist after a few glasses of wine may have the same ideas when normal as when elevated, but in the normal state their expression is inhibited by something that he would probably describe as the thought that the ideas were too trivial to express.

If the essence of the manic state is the removal of inhibitions, it follows as a corollary that maximum efforts must be higher in the manic state than in the normal state. Maximum efforts may not be so easy to obtain, owing to distractibility, nor may the reactions be so well adjusted to the environment, owing to clouded judgment. But the inferiority that manic cases are very apt to show in psychological tests demanding special co-operative effort is probably mainly secondary to the first of these factors. If as

[7] Brain, Vol. XXXI, Part CXXIII, 1908, pp. 451-489.

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good " attention " or concentration could be obtained as with the normal state, the maximum performance should be better.

It must probably be regarded as a limitation of the German terminology that it uses the word *Hemmung* to describe both retardation and inhibition. Hoch has indicated this difficulty very clearly[8] in his studies of retardation, especially in his employment of the term *resistances* instead of *inhibitions* to describe the process. That psychomotor retardation is the product of excessive inhibition is more than doubtful. Inhibition is opposition, and excessive inhibition is nothing more nor less than a blocking negativism, which is not part of the recognized symptomatology of manic-depressive insanity. This is a difficulty that must be overcome if the strict continuity of the manic and depressed states is to be maintained together with the theory of decreased inhibition in the manic states. We must recognize two factors that may lessen the freedom of a mental or motor reaction—opposition and obstruction. Excess of the former is negativism, excess of the latter is retardation. The crucial question then becomes : Is the manic state a removal of inhibitions or a removal of obstructions? Removal of inhibitions describes the manic state as we know it very well, but excessive inhibitions describes something very different from the retarded state. On the other hand, excess of obstructions describes the retarded state very well, while its relation to the manic state is the same as that of the theory of loss of inhibition. Both viewpoints are compelled to conceive of some process which acts independently upon the primary or the inhibitory impulses, for if they were equally affected the end-effects would remain essentially unchanged. The point is perhaps a minor one, but for the sake of clearness it might be well to examine the objective criteria of obstruction, or resistances, as distinguished from inhibitions, with reference to the more precise analysis of the manic state.

Such phenomena of retardation as appear in the dementia præcox cases observed are objectively differentiated from the depressive ones in that they appear more episodically, almost fortuitously, as it were, affecting one hand and not the other, or only individual series with a single hand, as distinguished from

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[8] Hoch: On Certain Studies with the Ergograph. Journ. Nerv. and Ment. Diseases, XXVIII, 1901, p. 626.

the manic-depressive retardation whose manifestations are more consistent throughout. However, while there have not been observed outside the depressed states instances of the phenomena of retardation which did not seem to have objectively a different origin from those regularly observed within the depressed states, yet the possibility must be granted that the retardation measured in these experiments may be a symptom of many mental diseases, possibly in much the same way as a rise in temperature is a frequent accompaniment of bodily disorders. We do not discard the clinical thermometer because it will not immediately distinguish between the fever of a typhoid and the fever of a pneumonia; nor need the measurement of retardation lose its clinical significance because it will not serve the purposes of penny-in-the-slot diagnosis.

To briefly recapitulate. The measurement of such elementary functions as are given in the ocular reaction times, the ocular pursuit movements, or the tapping test and the like, affords the most unequivocal criterion of motor retardation that it is at present practicable to obtain. The criteria of motor retardation as illustrated by the tapping test are (a) a lowered absolute rate, (b) a rise in the work-curve where it should normally fall (reversal), (c) a relative gain over the normal in the efficiency of the work that comes later in the experiments (transference). Case I, superficially characterized mainly by fixed ideas, illustrated marked phenomena of retardation under the conditions of the experiment, indicating the existence of a more fundamental psychic disturbance to which the fixed ideas are secondary. Later, this case showed extreme instability of the phenomena of retardation, which markedly decreased through the experiments, a progressive change which the mood tended to parallel. Case II illustrated a pronounced motor retardation, probably without much thinking disorder. Here there were also to be noted characteristic fluctuations as the experimental work progressed. Case III was mainly significant in showing that the phenomena of retardation might appear characteristically in a first attack at the involution period, in giving an especially clear-cut illustration of transference phenomena and further reflecting episodic changes in condition.

Case IV illustrates the effect of an objectively given condition of retardation in accentuating the phenomena of transference and

lowered absolute rate. Case V illustrated certain phenomena in retardation in a depression of immediate traumatic antecedents, and with other clinical characters of the traumatic psychosis. In Case VI the characteristic phenomena of manic-depressive retardation appeared in a case showing otherwise many dementia præcox traits, but whose subsequent course was more favorable than is usually to be anticipated in this condition. In Cases VII and VIII a considerable clinical retardation failed to reveal itself in any characteristic way experimentally; in each of these cases the possibility of a general paralysis had been considered. Case IX is a classical involution depression whose deviations from the normal are in the opposite direction from those of the manic-depressive depressions. No retardation is shown and, save for the lowering of the gross rate, the performance resembles that of the manic cases more than that of the typical manic-depressive depressions. The performance is also practically unaffected by considerable fluctuations in the superficial condition. Cases X and XI are presented in this same connection, as agitated depressions not showing retardation; and affording, with the three previous cases, experimental indication that emotional depression involves retardation no more necessarily than retardation involves emotional depression. Each is seen fundamentally and independent of the other, though either may be secondary to the other.

The cases of dementia præcox and general paralysis show little or nothing of significance, but the manic cases tend to show an increased initial rate and a heightened susceptibility to fatigue, the exact reverse of what is shown by the retarded cases. When the psychological measure can be made sufficiently independent of special factors in co-operation it is probable that the optimum performance of manic states is quite superior to the normal as well as the depressed. Insufficient light exists on this question, however, a satisfactory treatment of which is possible only in the study of a group of circular cases through various periods of depression and excitement. Since the essentially retarded state is almost certainly an over-obstruction, not an over-inhibition, of the reaction, the manic state may also perhaps be better interpreted as the loss of normal and teleological obstruction to the primary impulses rather than to the loss of an inhibitory faculty usually exercised by the opposite impulses.